

CLAIMS:

1. A wheel-state obtaining apparatus comprising:

5 a wheel-side device (10-16; 10b-16b; 200-206; 300-306; 400a-400d; 500) provided for each of at least one of a plurality of wheels (FR, FL, RR, RL) of a vehicle and including a first-wheel-state detecting device (32; 212; 312; 412; 504) operable to detect a first state of the corresponding wheel; and

10 a body-side device (18; 18b; 230; 330; 404; 520) disposed on a body of the vehicle and including (a) a detected-information obtaining device (52; 252; 352; 424; 512) operable to obtain detected information representative of the first state of said corresponding wheel detected by said first-wheel-state detecting device, (b) a vehicle-state detecting device (60-66; 360-364; 420; 15 516) operable to detect a state of the vehicle, (c) an estimated-information obtaining device (54; 254; 354; 426; 518) operable to estimate said first state of said corresponding wheel on the basis of at least the state of the vehicle detected by said vehicle-state detecting device, and obtain estimated information 20 representative of the estimated first state, and (d) a determining device (55; 255; 355; 428; 522) operable to determine one of said detected information and said estimated information, as wheel-state information representative of said first state of said corresponding wheel.

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2. A wheel-state obtaining apparatus according to claim 1, wherein said determining device includes an individually determining portion operable for each of said plurality of wheels, independently of each other, such that one of said detected 30 information and said estimated information is determined as said wheel-state information for each of said plurality of wheels.

3. A wheel-state obtaining apparatus according to claim 1, wherein said determining device includes an overall determining 35 portion operable for all of said plurality of wheels, such that one of said detected information and said estimated information is determined as said wheel-state information, commonly for all of

said plurality of wheels.

4. A wheel-state obtaining apparatus according to any one of claims 1-3, wherein said determining device includes a
5 detection-failure estimated-information obtaining portion (55; 355; 428; 522) operable to determine said detected information as said wheel-state information when said first state of said corresponding wheel has been detected by said first-wheel-state detecting device (32; 312; 412; 516), and determine said
10 estimated information as said wheel-state information when said first state has not been detected by said first-wheel-state detecting device.

5. A wheel-state obtaining apparatus according to any one of
15 claims 1-4, wherein said wheel-side device further includes (a) a wheel-side-information transmitting device (36; 36b; 216; 316; 416; 506) operable to transmit, in a wireless fashion, wheel-side information representative of said first state of said corresponding wheel detected by said first-wheel-state detecting
20 device, and (b) an electric power source (38; 218; 318; 418) operable to supply said wheel-side-information transmitting device and said first-wheel-state detecting device with an electric energy, and said body-side device further includes a receiving device (20-26; 20b-26b; 240-246; 332-338; 419a-419d; 510)
25 operable to receive said wheel-side information transmitted from said wheel-side device, said detected-information obtaining device including a detected-information extracting portion (52; 252; 352; 424; 512) operable to extract from said wheel-side information said detected information representative of the first
30 state of said corresponding wheel.

6. A wheel-state obtaining apparatus according to claim 5, wherein said determining device includes a
35 reception-condition-dependent determining portion operable to determine one of said detected information and said estimated information as said wheel-state information, on the basis of a condition of reception of said wheel-side information by said

receiving device.

7. A wheel-state obtaining apparatus according to claim 5 or 6, wherein said determining device includes a determining portion operable to determine said estimated information as said wheel-state information when said wheel-side information has not been normally received by said receiving device, and determine said detected information as said wheel-state information when said wheel-side information has been normally received by said receiving device.

8. A wheel-state obtaining apparatus according to claim 7, wherein said determining portion determines said estimated information as said wheel-state information when said wheel-side information received by said receiving device is abnormal, and determines said estimated information as said wheel-state information when said wheel-state information received by said receiving device is normal.

9. A wheel-state obtaining apparatus according to any one of claims 5-8, wherein said determining device includes a reception-failure estimated-information determining portion (55; 355; 428; 522) operable to determine said estimated information as said wheel-state information when said wheel-side information has not been received by said receiving device, at a predetermined timing of reception of said wheel-side information by said receiving device.

10. A wheel-state obtaining apparatus according to claim 9, wherein said wheel-side-information transmitting device includes a periodically transmitting portion (36; 316; 416; 506) operable to transmit said wheel-side information at a predetermined interval of transmission.

11. A wheel-state obtaining apparatus according to any one of claims 5-10, wherein said wheel-side-information transmitting device includes a periodically transmitting portion (36; 36b; 216;

316; 416; 506) operable to transmit said wheel-side information at a predetermined interval of transmission, and said estimated-information obtaining device (54; 254; 354; 426; 518) is operable to obtain said estimated information during a
5 predetermined interval of reception of said wheel-side information by said receiving device (20-26; 20b-26b; 240-246; 332-338; 419a-419d; 510).

12. A wheel-state obtaining apparatus according to any one of
10 claims 5-11, wherein said determining device (55) includes a reception-condition determining portion operable to determine whether a ratio of reception of said wheel-side information by said receiving device (20b-26b) is relatively high or low, and a reception-condition-dependent determining portion operable to
15 determine said detected information as said wheel-state information when said reception-condition determining portion determines that said ratio of reception is relatively high, and determine said estimated information as said wheel-state information when said reception-condition determining portion
20 determines that said ratio of reception is relatively low.

13. A wheel-state obtaining apparatus according to any one of claims 1-12, wherein said vehicle-state detecting device includes a second-wheel-state detecting device (60-66; 360-364; 420; 516)
25 operable to detect a second state of each of at least one of said plurality of wheels, said second state being different from said first state.

14. A wheel-state obtaining apparatus according to any one of
30 claims 5-13, wherein said estimated-information obtaining device includes a detected-state estimating (54; 354; 426; 518) operable to estimate said first state of said corresponding wheel after last reception of said wheel-side information by said receiving device (20-26; 332-338; 419a-419d; 510), on the basis of at least said first
35 state of said corresponding wheel represented by the wheel-side information received last by said receiving device.

15. A wheel-state obtaining apparatus according to claim 14,

wherein said vehicle-state detecting device includes a second-wheel-state detecting device (60-66; 360-364; 420; 516) operable to detect a second state of each of at least one of said plurality of wheels, said second state being different from said first state, and said detected-state estimating portion estimates said first state of said corresponding wheel, on the basis of said first state represented by the wheel-side information received last by said receiving device, and said second state detected by said second-wheel-state detecting device.

16. A wheel-state obtaining apparatus according to any one of claims 13-15, wherein said detected-state estimating portion includes an estimating portion operable to estimate said first state of said corresponding wheel, according to a predetermined rule on the basis of said second state of each of said at least one of said plurality of wheels detected by said second-wheel-state detecting device, and a rule-changing portion operable to change said predetermined rule on the basis of said first state of said corresponding wheel represented by said detected information which has been extracted by said detected-information obtaining device from the last received wheel-side information.

17. A wheel-state obtaining apparatus according to any one of claims 13-16, wherein said detected-state estimating portion includes a provisionally estimating portion (S2-S4) operable to obtain a provisional estimated value of said first state of said corresponding wheel on the basis of said second state of each of said at least one of said plurality of wheels detected by said second-wheel-state detecting device, and an estimated-information obtaining portion (S11) operable to compensate said provisional estimated value of said first state on the basis of said first state represented by said detected information extracted from said wheel-side information which has been received last by said receiving device, said estimated-information obtaining portion determining the compensated provisional estimated value of said first state as said estimated information.

18. A wheel-state obtaining apparatus according to any one of claims 13-16, wherein said detected-state estimating portion includes a provisionally estimating portion (S2-S4) operable to
5 obtain a provisional estimated value of said first state of said corresponding wheel on the basis of said second state of each of said at least one of said plurality of wheels detected by said second-wheel-state detecting device, and a final-estimated-value obtaining portion (S11) operable to compensate said provisional
10 estimated value of said first state on the basis of a predetermined relationship between said first state represented by said detected information extracted from said wheel-side information received last by said receiving device, and the provisional estimated value obtained at a moment substantially coincident with a moment at
15 which said wheel-side information was received last by said receiving device, said final-estimated-value obtaining portion determining the compensated provisional estimated value of said first state as a final estimated value of said first state.

20 19. A wheel-state obtaining apparatus according to any one of claims 1-18, wherein said estimated-information obtaining device includes an other-wheel-dependent estimating portion (S77-S86, S88-S92; S102-S107) operable to estimate said first state of said corresponding wheel on the basis of said first state of at least one
25 other wheel of said plurality of wheels, for obtaining the estimated information representative of the estimated first state.

20. A wheel-state obtaining apparatus according to claim 19, wherein said first-wheel-state detecting device (32) is provided
30 for each of at least two wheels of said plurality of wheels, and said vehicle-state detecting device includes a second-wheel-state detecting device (60-66) operable to detect a second state of each of said at least two wheels, which second state is different from said first state, said other-wheel-dependent estimating portion
35 obtaining said estimated information of one of two wheels of said plurality of wheels, by estimating said first state of said one of said two wheels, on the basis of said second state of said two

wheels detected by said second-wheel-state detecting device, and said first state of the other of said two wheels detected by said first-wheel-state detecting device.

5 21. A wheel-state obtaining apparatus according to any one of claims 1-20, wherein said vehicle-state detecting device includes a second-wheel-state detecting device (60-66; 360-364; 420; 516) operable to detect a second state of each of at least one of said plurality of wheels, said at least one of said plurality of wheels
10 including another wheel different from said corresponding wheel, said second state being different from said first state, and wherein said estimated-information obtaining device includes a relation-dependent estimated-information obtaining portion operable to estimate said first state of said corresponding wheel
15 to obtain said estimated information representative of the estimated first state of said corresponding wheel, on the basis of at least said second state of said another wheel detected by said second-wheel-state detecting device, and on the basis of a predetermined relationship between the second states of said
20 corresponding wheel and said another wheel.

22. A wheel-state obtaining apparatus according to any one of claims 1-21, wherein said vehicle-state detecting device includes a second-wheel-state detecting device (60-66) operable to detect a
25 quantity of a second state of each of at least two wheels of said plurality of wheels, said at least two wheels including said corresponding wheel, said second state being different from said first state, and wherein said estimated-information obtaining device includes an estimated-information obtaining portion
30 (S35-S36) operable to estimate said first state of said corresponding wheel to obtain said estimated information representative of the estimated first state of said corresponding wheel, on the basis of at least a relationship between the quantity of said second state of said corresponding wheel
35 detected by said second-wheel-state detecting device, and an average of the quantities of said second states of said at least two wheels detected by said second-wheel-state detecting device.

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23. A wheel-state obtaining apparatus according to any one of claims 1-22, wherein said vehicle-state detecting device includes a second-wheel-state detecting device operable to detect a second state of said corresponding wheel, said second state being different from said first state, and said estimated-information obtaining device (54) includes (a) a first-estimated-information obtaining portion (54a, S163) operable to estimate said first state of said corresponding wheel on the basis of said first state of at least one other wheel of said plurality of wheels, to obtain first estimated information, and (b) a second-estimated-information obtaining portion (54b, S161) operable to estimate said first state of said corresponding wheel on the basis of said second state of said corresponding wheel, to obtain second estimated information, and wherein said determining device (55) includes a selecting portion (S157-S158) operable to select one of said first estimated information and said second estimated information, when said determining device determines said estimated information as said wheel-state information.

24. A wheel-state obtaining apparatus according to any one of claims 1-23, wherein said determining device includes (a) a vehicle-state detecting portion (60-66, 78-81; 260-270) operable to detect a state of the vehicle, and (b) a vehicle-state-dependent determining portion (S154-S156; S202; S252-S252) operable to determine one of said detected information and said estimated information as said wheel-state information, on the basis of the state of the vehicle detected by said vehicle-state detecting portion.

25. A wheel-state obtaining apparatus according to claim 24, wherein said vehicle-state detecting portion includes a vehicle-running-state detecting device (60-66, 78-81) operable to detect a running state of the vehicle, and said vehicle-state-dependent determining portion includes a vehicle-running-state-dependent determining portion operable to determine one of said detected information and said estimated

information as said wheel-state information, on the basis of the running state of the vehicle detected by said vehicle-running-state detecting portion.

5 26. A wheel-state obtaining apparatus according to any one of claims 1-2, wherein said determining device includes (a) a roadway-surface detecting portion (60-66) operable to detect a condition of a roadway surface on which the vehicle is running, and (b) a roadway-condition-dependent determining portion
10 (S154) operable to determine one of said detected information and said estimated information as said wheel-state information, on the basis of the condition of said roadway surface detected by said roadway-surface detecting portion.

15 27. A wheel-state obtaining apparatus according to any one of claims 1-26, wherein said determining device includes a determining portion (S201-S203) operable to determine said estimated information as said wheel-state information, when a state of change of said estimated information as obtained by said
20 estimated-information obtaining device is smaller than a predetermined state.

28. A wheel-state obtaining apparatus according to any one of the above modes (1)-(27), wherein said determining device
25 includes an independently determining portion (S154-S156; S202; S251-S252) operable to determine one of said detected information and said estimated information as said wheel-state information representative of said first state of each of said plurality of wheels, such that said detected information is
30 selected as said wheel-state information of at least one of said plurality of wheels, while said estimated information is selected as said wheel-state information of the other of said plurality of wheels.

35 29. A wheel-state obtaining apparatus according to any one of claims 5-28, wherein said wheel-side device further includes a transmission control device (75) operable to control a state of

transmission of said wheel-side information from said wheel-side-information transmitting device (36; 36b; 216; 316).

5 30. A wheel-state obtaining apparatus according to claim 29, wherein said transmission control device includes at least one of (a) a transmission permitting/inhibiting portion (S177-S178; S212, S216) operable to permit or inhibit transmission of said wheel-side information from said wheel-side-information transmitting device, on the basis of a state of change of said first
10 state of said corresponding wheel detected by said first-wheel-state detecting device (32), and (b) a transmission restricting portion (S185) operable to restrict the transmission of said wheel-side information from said wheel-side-information transmitting device, when the change of said first state detected
15 by said first-wheel-state detecting device is slower than a predetermined threshold.

20 31. A wheel-state obtaining apparatus according to claim 29 or 30, wherein said wheel-side device further includes (a) a wheel-side-information generating device (34) operable to generate said wheel-side information on the basis of said first state of said corresponding wheel detected by said first-wheel-state detecting device (32), and (b) a
25 generating-device control device (40b) operable to control said wheel-side-information generating device on the basis of a state of change of said first state detected by said first-wheel-state detecting device.

30 32. A wheel-state obtaining apparatus according to any one of claims 29-31, wherein said body-side device further includes a transmission-state-control-information generating device (76) operable to transmit to said wheel-side device (10b-16b) transmission-state control information indicative of a state of transmission of said wheel-side information from said
35 wheel-side-information transmitting device (36b), and said wheel-side device further includes a body-side-information receiving device (36b) operable to receive information from said

body-side device, said transmission control device (75) controlling said wheel-side-information transmitting device according to said transmission-state control information received by said body-side-information receiving device.

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33. A wheel-state obtaining apparatus according to claim 32, wherein transmission-state-control-information transmitting device is operable to transmit to said wheel-side device at least one of (a) information which permits the transmission of said
10 wheel-side information, and (b) information which requires the transmission of said wheel-side information, when an accuracy of said estimated information obtained by said estimated-information obtaining device is lower than a predetermined threshold.

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34. A wheel-state obtaining apparatus according to any one of claims 1-33, wherein said first-wheel-state detecting device includes at least one of (a) an air-pressure-state detecting device (32) operable to detect a state of an air pressure in a tire (31) of
20 said corresponding wheel, (b) a temperature-state detecting device (212) operable to detect a state of a temperature of said tire, (c) a force-state detecting device (312) operable to detect a state of forces acting on said corresponding wheel, and (d) a rotation-state detecting device (412) operable to detect a state of
25 rotation of said corresponding wheel.

35. A wheel-state obtaining apparatus according to any one of claims 1-34, wherein said first-wheel-state detecting device includes an air-pressure-state detecting device (32) operable to
30 detect a state of an air pressure in a tire (31) of each of at least one of said plurality of wheels, and said vehicle-state detecting device includes a speed detecting device (60-66) operable to detect a rotating speed of each of at least one of said plurality of wheels, said estimated-information obtaining device including an
35 estimated-air-pressure-information obtaining portion (54) operable to estimate the air pressure of each of said at least one of the plurality of wheels on the basis of the rotating speed

detected by said speed detecting device, to obtain estimated-air-pressure information representative of the estimated air pressure.

5 36. A wheel-state obtaining apparatus according to any one of
claims 1-35, wherein said first-wheel-state detecting device
includes a temperature-state detecting device (212) operable to
detect a state of a temperature of a tire (31) of each of at least
one of said plurality of wheels, and said vehicle-state detecting
10 device includes a running-time/distance detecting device (272)
operable to detect at least one of a cumulative running time and
a cumulative running distance of the vehicle, said
estimated-information obtaining device including an
estimated-temperature-state-information obtaining portion (254)
15 operable to estimate the state of the temperature of the tire of
each of said at least one of the plurality of wheels, on the basis of
at least one of said cumulative running time and distance
detected by said running-time/distance detecting device, to obtain
estimated-temperature-state information representative of the
20 estimated state of the temperature.

37. A wheel-state obtaining apparatus according to any one of
claims 1-36, wherein said first-wheel-state detecting device
includes a temperature-state detecting device (212) operable to
25 detect a state of a temperature of a tire (31) of each of at least
one of said plurality of wheels, and said vehicle-state detecting
device includes (a) a load detecting device (262-268) operable to
detect a load acting on each of said at least one of the plurality of
wheels, (b) a running-state detecting device (260) operable to
30 detect a running state of the vehicle, and (c) an
ambient-temperature detecting device (270) operable to detect an
ambient temperature of the vehicle, said estimated-information
obtaining device including an
estimated-temperature-state-information obtaining portion (254)
35 operable to estimate the state of the temperature of the tire of
each of said at least one of the plurality of wheels, on the basis of
the detected load acting on said each wheel and the detected

ambient temperature and running state of the vehicle, to obtain estimated-temperature-state information representative of the estimated state of the temperature.

5 38. A wheel-state obtaining apparatus according to any one of claims 1-37, wherein said first-wheel-state detecting device includes a force-detecting device (312; 412) operable to detect at least one force acting on each of at least one of said plurality of wheels, and said vehicle-state detecting device includes at least
10 one of (a) a driving-state detecting device (360) operable to detect a driving state of the vehicle, (b) a braking-state detecting device (372) operable to detect a braking state of the vehicle, and (c) a turning-state detecting device (364) operable to detect a turning state of the vehicle, said estimated-information obtaining device
15 including an estimated-force-information obtaining portion (354; 426) operable to estimate said at least one force acting on each of said at least one of the plurality of wheels on the basis of at least one of the detected accelerating, braking and turning states of the vehicle, to obtain estimated-force information representative
20 of the estimated at least one force.

39. A wheel-state obtaining apparatus comprising:

a wheel-side device (10-16; 10b-16b; 200-206; 300-306; 400a-400d; 500) provided for each of at least one of a plurality of
25 wheels (FR, FL, RR, RL) of a vehicle and including (a) a first-wheel-state detecting device (32; 212; 312; 412; 504) operable to detect a first state of the corresponding wheel, and (b) a wheel-side-information transmitting device (36; 36b; 216; 316; 416; 506) operable to transmit, in a wireless fashion, wheel-side
30 information representative of said first state of said corresponding wheel detected by said first-wheel-state detecting device; and

a body-side device (18; 18b; 230; 330; 404; 520) disposed on a body of the vehicle and including (c) a receiving device (20-26;
35 20b-26b; 240-246; 332-338; 419a-419d; 510) operable to receive said wheel-side information transmitted from said wheel-side device, (d) a detected-information obtaining device (52; 252; 352;

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424; 512) operable to obtain received-information representative of the first state of said corresponding wheel, from said wheel-side information received by said receiving device, (e) a vehicle-state detecting device (60-66; 360-364; 420; 516) operable to detect a state of the vehicle, (f) an estimated-information obtaining device (54; 254; 354; 427; 518) operable to estimate said first state of said corresponding wheel, on the basis of at least the state of the vehicle detected by said vehicle-state detecting device, and obtain estimated information representative of the estimated first state, and (g) an obtaining-device selecting portion (55; 255; 355; 428; 522) operable to select one of said estimated-information obtaining device and said detected-information obtaining device.

40. A wheel-state obtaining apparatus comprising:

a wheel-side device (10-16; 10b-16b; 200-206; 300-306; 400a-400d; 500) provided for each of at least one of a plurality of wheels (FR, FL, RR, RL) of a vehicle and including (a) a first-wheel-state detecting device (32; 212; 312; 412; 504) operable to detect a first state of the corresponding wheel, and (b) a wheel-side-information transmitting device (36; 36b; 216; 316; 416; 506) operable to transmit, in a wireless fashion, wheel-side information representative of said first state of said corresponding wheel detected by said first-wheel-state detecting device; and

a body-side device (18; 18b; 230; 330; 404; 520) disposed on a body of the vehicle and including (c) a receiving device (20-26; 20b-26b; 240-246; 332-338; 419a-419d; 510) operable to receive said wheel-side information transmitted from said wheel-side device, (d) a detected-information obtaining device (52; 252; 352; 424; 512) operable to obtain detected-information representative of the first state of said corresponding wheel, from said wheel-side information received by said receiving device, (e) a vehicle-state detecting device (60-66; 360-364; 420; 516) operable to detect a state of the vehicle, and (f) an estimated-information obtaining device (54; 254; 354; 427; 518) operable, when said wheel-side information has not been received by said receiving

device, to estimate said first state of said corresponding wheel, on the basis of at least the state of the vehicle detected by said vehicle-state detecting device, and obtain estimated information representative of the estimated first state.

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41. A vehicle-state obtaining apparatus comprising:

- a remote detecting device (10-16; 10b-16b; 200-206; 300-306; 400a-400d; 500) including a first detecting device (32; 212; 312; 412; 504), and a transmitting device (36; 36b; 216; 316; 416; 506) operable to transmit, in a wireless fashion, first-detecting-device information including information indicative of an output of said first detecting device; and
- an information processing device (18; 18b; 230; 330; 404; 520) including (a) a remote-information obtaining device (20-26, 52; 20b-26b, 52; 240-246, 252; 332-338, 352; 402; 514) including a receiving device (20-26; 20b-26b; 240-246; 332-338; 419a-419d; 510) operable to receive said first-detecting-device information transmitted in a wireless fashion from said remote detecting device, said remote-information obtaining device being operable to obtain remote information representative of a state of the vehicle, on the basis of said first-detecting-device information received by said receiving device, (b) a wire-transmission-dependent-information obtaining device (60-69, 54; 60-69, 254; 354, 360-364; 404; 520) including a second detecting device (60-66; 360-364; 420; 516) and operable to obtain wire-transmission-dependent information representative of said state of the vehicle, on the basis of second-detecting-device information which has been transmitted from said second detecting device through a signal line (69; 422) and which includes information indicative of an output of said second detecting device, and (c) an information determining device (55; 255; 355; 428; 522) operable to determine one of said wire-transmission-dependent information and said remote information, as vehicle-state information representative of said state of the vehicle.

42. A vehicle-state obtaining apparatus according to claim 41,

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wherein said first detecting device is operable to detect one state of said vehicle as said state of the vehicle, while said second detecting device is operable to detect another state of the vehicle which is different from said one state, and said
5 wire-transmission-dependent-information obtaining device includes an estimating portion (54; 254; 354; 426; 518) operable to estimate said one state of the vehicle on the basis of said another state of the vehicle detected by said second detecting device.

10 43. A vehicle state obtaining apparatus according to claim 41 or 42, wherein said remote detecting device is provided on a sprung member of the vehicle, while said information processing device is provided on an unsprung member of the vehicle.

15 44. A vehicle-state obtaining apparatus according to any one of claims 41-43, wherein said remote detecting device is provided on a wheel of the vehicle.

20 45. A vehicle-state obtaining apparatus according to any one of claims 41-44, wherein said information determining device is operable to determine said wire-transmission-dependent information as said vehicle-state information, when said remote information has not been received by said remote-information
25 obtaining device.

46. A vehicle-state indicating apparatus comprising:
a wheel-state obtaining apparatus as defined in any one of claims 1-40;

30 a judging device (56; 256; 356) operable to determine whether said first state of said corresponding wheel is normal or not; and

an indicator device (70; 430; 524) operable, when said judging device determines that said first state of said
35 corresponding wheel is not normal, to provide an indication that said first state is not normal.

47. A vehicle-state control apparatus comprising:
a wheel-state obtaining apparatus as defined in any one of
claims 1-40;

5 an actuator portion (104; 122) operable to control a state of
the vehicle; and

an actuator control portion (106; 124) operable to control
said actuator portion on the basis of said first state of said
corresponding wheel obtained by said wheel-state obtaining
apparatus.

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48. A wheel-state control apparatus comprising:

a wheel-state obtaining apparatus as defined in any one of
claims 1-40;

15 an actuator portion (104; 122) operable to control said first
state of said corresponding wheel; and

an actuator control portion (106; 124) operable to control
said actuator portion such that said first state of said
corresponding wheel obtained by said wheel-state obtaining
apparatus is held within a predetermined range.

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